ONTARIO AGRICULTURAL COLLEGE.

BULLETIN XCII.

DISEASES AFFECTING THE GRAPE

By J. H. Panton, M.A., F.G.S., Professor of Natural History and Geology.

ALSO SPECIAL BULLETINS.

APPLES ..... By D. W. Beadle, Toronto.
STRAWBERRIES ... By W. W. Hilborn, Leamington.
PLUMS ..... By G. W. Cline, Winona.
FRUIT STATISTICS. Bureau of Industries.

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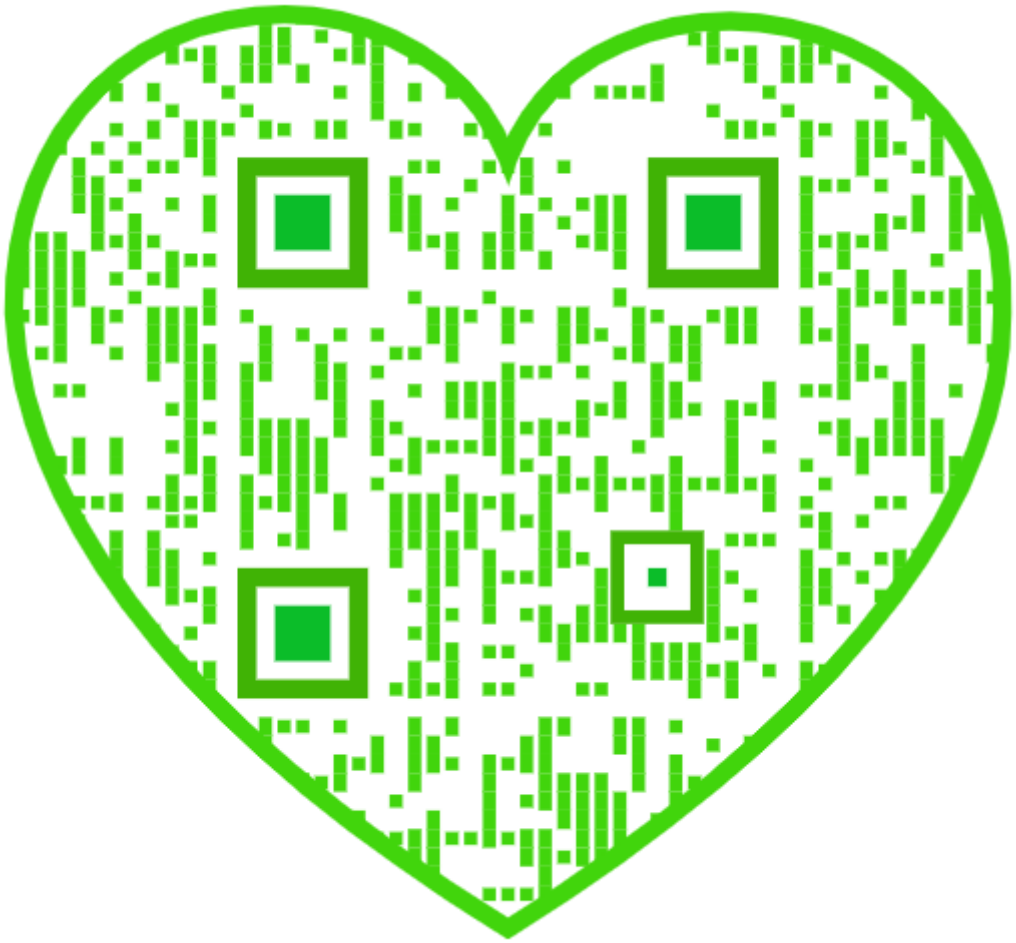

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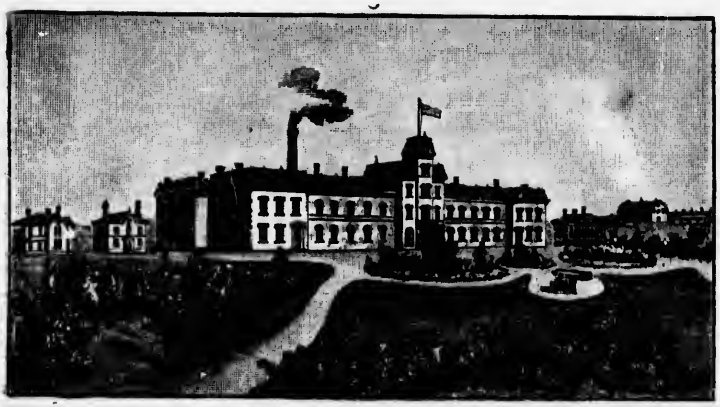

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DISEASES AFFECTING THE GRAPE.

By J. H. Panton, M.A., F.G.S., Professor of Natural History and Geology, Ontario Agricultural College, Guelph, Ont.

Having received replies from 551 persons to whom circulars were sent through the medium of the Department of Agriculture for information regarding diseases affecting the grape, the writer is able to present a summary of these replies, and, as the time is now opportune, give a description of four of the most common parasitic plants attacking the grape, and also give information as to the best means to prevent the spread and effect of these diseases.

Of the correspondents making returns, 120 report Downy Mildew, 105 Powdery Mildew, 106 Black Rot, and 14 Anthracnose.

The county of Welland reported 60 per cent. loss, Wentworth 70 per cent., Lincoln 75 per cent., and Essex 50 per cent.

As to varieties most liable to attack, 116 correspondents report Rogers' hybrids, 35 Concord, 23 Clinton, 20 Niagara, 15 Brighton, and 12 Delaware.

The year 1889 is frequently referred to as the season when these diseases were first noticed to any considerable extent, and they have been on the increase since. Grape growers are awakening to the importance and necessity of fighting these foes, as may be seen from the fact that of those in communication with the Department in reply to the circular above referred to, 59 report using sulphur, 45 Bordeaux mixture, 12 copper sulphate, 10 ammoniacal solution of copper sulphate, and 3 eau celeste. The consensus of opinion is that favorable results followed the use of the above name fungicides, especially in the case of the Bordeaux mixture.

Thirty-two persons report that they found farmyard manure to favor the development of these fungoid pests. Many find ashes an excellent fertilizer for the grape vine.

Fungoid Pests.

The grape being a plant that produces a large amount of foliage and fruit, it is not a matter of surprise that it should have a number of enemies among insects and parasitic plants. In this Bulletin we wish to direct the attention of readers to four plants that are found affecting the grape injuriously, by deriving their nourishment from it as parasites upon its leaves, canes and fruit.

No group of plants has received more attention, since the establishment of experiment stations, than what is called the fungi, and no investigations have been more productive in practical results than those which have been followed to ascertain the nature and remedy for plant diseases, caused by species of fungi. Until the microscope was discovered and its manipulation simplified, we knew very little

concerning the life history of these pests, most of them being exceedingly minute.

General Characteristics of the Fungi.

The fungi include most of these parasites, that commence life from a spore which to some extent corresponds to a seed, the starting point for the higher forms of plant life, as the grape, etc. Spores are exceedingly small, most of them microscopic, have a very thin covering, germinate from no particular point, and have no embryo. Thus you will perceive they differ very materially from a seed, which is visible, has a well defined covering, germinates from a particular point, and contains an embryo, that develops into a plant capable of producing flowers and seeds.

The fungi also differ from other plants in having no green coloring matter (Chlorophyll) in them, and thus cannot elaborate food from inorganic material; they must derive their food from material elaborated by plants that do possess Chlorophyll. They therefore live on organic matter, some on dead, such as mushrooms, others on living, such as mildews, smuts, etc. The latter are true parasites, and are very injurious by sapping the vitality from the plants upon which they are found. Among these fungi we find four frequently parasitic upon the grape. Before discussing these specific forms, it may be of service to the reader to outline the usual development of a parasitic fungus from the germination of spore till spores are again produced. Spores being exceedingly small are readily transported by the wind, and soon reach a suitable place for germination upon some plant, which is termed the host. The minute germinal thread which at first appears soon penetrates the tissue of the host plant and continues growing among the cells, from the contents of which it derives nourishment. As growth proceeds, thread like structures (*hyphæ*) increase, and usually form quite a complicated mass (*mycelium*) pervading the tissues of the affected plant. The growth of this has a very disastrous effect upon the plant attacked, by lessening its vitality and general growth. At the proper time certain structures arise from the mass (*mycelium*). These vary much in the different fungi; but all are concerned in the production of spores, which falling upon proper places and surrounded by favorable conditions, soon germinate and perpetuate the disease.

This first form of spore (Summer spore) is usually developed early in the season and in great numbers, their use being the rapid spread of the fungus. Their vitality is chiefly confined to the season in which they are produced; but later in the season, among the threads of the mass, more complicated structures appear. The elements they contain mingle together and give rise to much more durable spores (Winter spores) which are destined to carry the trouble into another season.

They are capable of surviving more adverse conditions than the summer spores. By burning up affected material in winter or early spring, before the winter spores have germinated, we can prevent to a considerable extent the spread of a fungus. Remembering this outline, for it is much the same in all these parasitic fungi, the reader will be in a position to understand the following descriptions of certain specific forms feeding among the tissues of the grape.

Downy Mildew or Brown Rot (*Peronospora viticola.*)

This fungus which moisture seems to favor, attacks all green portions of the grape and appears about June. As soon as a spore falls upon the leaf, it germinates, and the germinal thread penetrates the tissue and passes between the cells, not into them; but small growths develop on the penetrating threads and these (*haustoria*) dip into the cells and abstract nourishment for the growing fungus. An examination of these minute threads by a microscope reveals no partitions, such as are observable in the threads of "Black Rot." As development continues the thread-like structures of the fungus increase and form a mass (*mycelium*) which pervades the host-plant; from this arise minute stalks, that make their appearance through the small openings (*stomata*) on the underside of the leaves, usually several in one opening. (See fig. 1). They appear in such numbers, as to form patches of a mouldy or frost-like appearance; opposite to these on the upper side of the leaves are pale green spots, which gradually turn brown, indicating a sickly condition of the leaf. These stalks under the microscope present quite a tree-like form as seen in the figure, and bear on the ends of the branches many oval bodies (*conidia*) which drop off as soon as they mature. If they reach favorable conditions, the contents soon break up and spores are formed; these pass out, each capable of moving about, and after reaching a proper resting

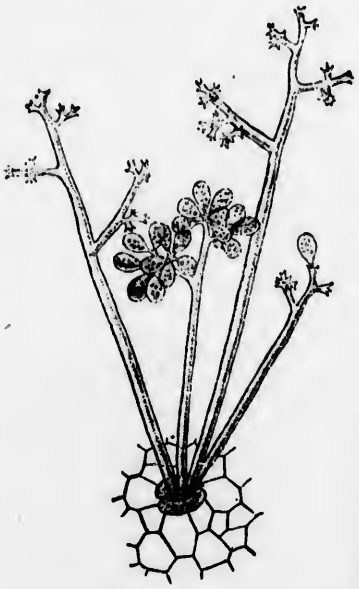

Fig. 1.

place, they germinate and the fungus again develops, as already described. These are summer spores and aid in spreading the fungus rapidly. Later in the season, about autumn, the winter spores are produced among the threads of the mycelium by a sexual process. They have much thicker walls and are fitted to withstand the adverse conditions of winter, and thus carry the trouble into another year. Hence the advisability of destroying leaves, etc., that might be suspected of having these winter spores upon them. When the shoots are attached it is indicated by dark colored spots slightly depressed, but not so deep as in the case of Anthracnose. Affected fruit fails to develop, it gradually becomes withered and brown. (See fig. 2). Hence the term "Brown Rot" applied to distinguish it from "Black Rot." In the latter the berries are very much wrinkled and dried up. (Compare figures A and B).

Fig. 2.

A

B

The Downy Mildew in its growth bears a close resemblance to the fungus causing "Potato Blight," described by the writer in the O.A.C. Report for 1886. A great many "blights" on different plants, turnips, lettuce, onion, cabbage, etc., are caused by parasites in the order (*Peronosporeæ*) to which the above belong.

Remedies.—1. Eau Celeste, a mixture of copper sulphate ammonia and sodium carbonate (see under conclusions at the end of this Bulletin) has been used very successfully against Downy Mildew by spraying as follows: 1st. Application ten days before the vines blossom; 2nd. Just after the blossoms fall, and 3rd, about two weeks later. 2. The Bordeaux mixture, copper sulphate, lime and water, as also referred to in the conclusions, is effective.

Black Rot of the Grape (*Laestadia Bidwellii.*)

This fungus, aided by moisture and high temperature, is often associated with rank and succulent growth. It affects leaves, shoots and berries, usually making its appearance in June, in the form of circular reddish brown spots, of lighter color in the centre. They are more distinct on the upper surface of the leaf, than on the lower. Around these diseased parts, minute dark colored pimples can be seen. These show the various stages in the growth of the fungus which we shall describe, when referring to the attack upon the fruit. On the shoots the disease causes long brown spots somewhat depressed. It is not in the attack upon either leaves or shoots that much damage is sustained, but when the fungus reaches the fruit. The berries are attacked shortly after the leaves show the presence of the disease. The trouble often shows itself as a small brownish spot on the surface, near the stem end; this gradually spreads and covers the whole surface, changing in color, till it becomes quite black and the berry eventually withers, assuming a dry, shrivelled up condition. (See figs. A and B, showing unaffected and affected fruit.) An examination of the surface reveals many small black pimples in which the fungus can be detected; these pustules can be seen by the eye, but sections of them under the microscope show many interesting stages in the life history of this parasite.

Its thread-like structures with partitions, during development not only grow between the cells, but in some cases penetrate them. Among the tissues of the shrivelled berries minute cavities are seen in which spores are developed. These cavities may be quite near each other, but contain entirely different forms of spores, for we find four kinds connected with the spread of this fungus. When mature the spores escape through minute openings on the surface of the pimples referred to.

Fig. 3.

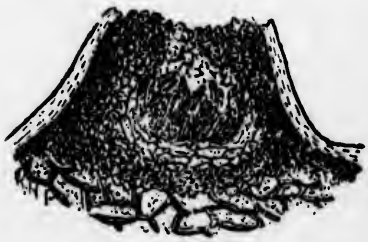

Fig 4.

Among the most important germs in spreading the fungus during

summer are the *Stylospores*, oval in outline and borne on very small stalks attached to the walls of certain cavities, (*pycnidia.*) As soon as mature they separate from the stalks and pass out of an opening on the top of a pimple. (See fig. 3.) Other cavities (*spermagonia*) give rise to still smaller and more elongated spores (*spermatia*) which mature and also pass out through an opening.

Ascopores, oval in outline, are not developed till the "rot" has been fully matured, and may be seen upon diseased berries in the spring. They are winter spores and are concerned in the perpetuation of the fungus from season to season. On this account it is very important to destroy them as far as possible. The cavities (*perithecia*) containing these are largely occupied by flask-shaped organs (*Asci*), (See fig. 4) in each of which are eight of these oval spores; these on reaching maturity escape from the cavities to find a new starting point on the plant.

Conidia, a fourth form of spore, are not so common as the others and are more usually found growing upon the surface of the pimples, than in cavities inside; they are oval and appear at the ends of stalks, showing well-marked divisions, from which they drop off, when mature. The *Stylospores* and *Ascospores* are the most important in the propagation of "Black Rot."

REMEDIES. 1. Some have succeeded in preserving the fruit from attack by enclosing the bunches in paper bags, as soon as the flowers are fertilized. 2. Spraying with Bordeaux Mixture (see conclusions) is a very successful fungicide against "Black Rot."

POWDERY MILDEW. *(Uncinula spiralis.)*

This fungus is quite different from either of the preceding in its form and habit; it prefers a dry atmosphere and confines its attack largely

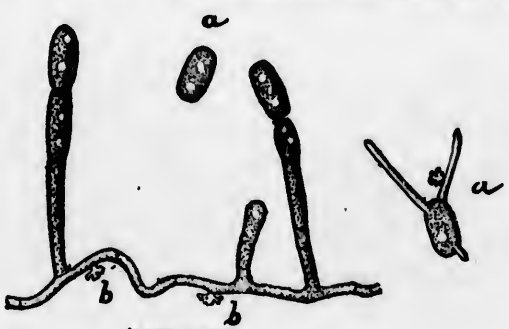

Fig. 5.

to the external portions of the affected parts. It appears about midsummer in the form of grayish white patches on the upper surface of the leaves, sometimes on the shoots and even berries. After it has developed for a time it throws up erect threads, each bearing single spores (*conidia*) at its summit; they drop off, and are followed by others taking their place, (see fig. 5.) and thus keep up a supply of summer spores. When the season advances many peculiar, minute, nutlike structures (*perithecia*) (see fig. 6.) are developed among the

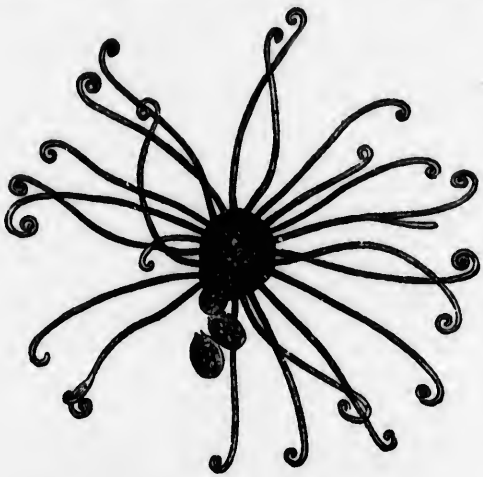

Fig. 6.

threads of the mass (*mycelium*). Within these, in small flask-shaped bodies (*Asci*), the winter spores (*Ascospores*) are developed, to continue the disease another year.

REMEDIES. 1. Sulphur has been very successful against this mildew by applying it, 1st. Twelve days before bloom; 2nd, when the plants are in bloom, and 3rd, three weeks later. 2. Bordeaux Mixture is also successful.

ANTHRACNOSE (*Sphaceloma ampelinum*).

Continued damp weather favors the development of this fungus, which may be found on all green parts, but more especially on the cane where it appears, as small brown marks, which sometimes

unite and form somewhat lengthened spots, the centres of which are sunken with a well raised border. The growing fungus does not extend deeply into the tissues, although the central area is depressed; but the affected parts rupture and spores are produced

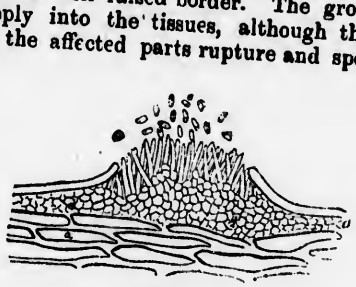

Fig. 7.

on the ends of mycelial threads; these drop off and form new centres of the disease. (See. fig. 7). On the leaves it produces minute brownish spots of lighter color in the centre and raised borders surrounding the whole.

When the berries become affected, they show brownish or blackish specks with a more or less circular outline; the centres of these become gray, and surrounding this sometimes a conspicuous red ring appears with a dark border on the outside of it. This presents

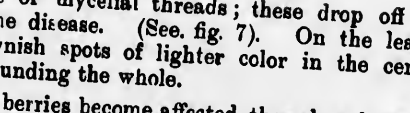

Fig. 8.

such a characteristic appearance, that the term "Bird's-eye Rot," (See fig. 8) has been applied to the disease. Berries attacked do not wither or turn brown as those referred to in "Black Rot" and "Brown Rot"; but the portion affected becomes somewhat wrinkled, and the berries assume an irregular shape. The spores of this seem to live during the winter upon the diseased portions of fruit, leaves or shoots.

REMEDIES. Sulphur has given good results. But it would be a great improvement to spray the canes with a solution of copper

sulphate (1 lb. copper sulphate in 20 gals. water) before the buds start. The careful and thorough application of Bordeaux mixture, as directed in the conclusions of this Bulletin, will be followed by but very slight if any attacks upon the grape, by the four parasitic plants discussed.

Conclusions.

From a study of the nature and habits of the fungi discussed in this Bulletin, we make the following conclusions:

1. Destroy as far as possible all affected material such as diseased leaves, canes and berries.

2. Before the buds start spray with a solution of copper sulphate (1 lb. in 25 gals. water).

3. After growth starts spray once at least before the vines bloom, using Bordeaux mixture (see below); if twice, make the first application as soon as the leaves appear and the second just before blooming.

4. After bloom, as soon as the fruit sets, make three applications at intervals of 12 to 15 days, with the Bordeaux mixture.

The coloring of the berries by this mixture may be overcome by using in the last application an ammoniacal solution of copper carbonate (see below); or it may be removed by dipping the fruit in a solution of vinegar (2 quarts vinegar in 10 gallons water) and then rinsing it in clean water.

5. The best fungicides to prevent the diseases of the grape are (*a*) copper sulphate, 1 lb. in 25 gals. water, for early treatment; (*b*) Bordeaux mixture, 6 lb. of copper sulphate, 4 lb. fresh lime, 45 gals. of water. In making this we grind the copper sulphate and dissolve it in a few gals. of water, slake the lime with about 6 gals. of water; after cooling strain it through some coarse sacking into the barrel that contains the copper sulphate solution and stir it well, adding the rest of the water necessary to make up the mixture; (*c*) eau celeste, 2 lb. copper sulphate, 2½ lb. washing soda, 2 pints ammonia and 25 gals. of water. Dissolve the copper sulphate in 2 gals. of water, the 2½ lb. washing soda in another vessel of water, mix these and when chemical action has ceased add 2 pints of ammonia; (*d*) ammoniacal solution copper carbonate; 3 oz. copper carbonate, 2 pints ammonia, 25 gals. water. Dissolve the 3 oz. of copper carbonate in 2 pints of ammonia, and when about to use dilute with 25 gals. water. Of these the Bordeaux mixture is likely to rank first.

6. These mixtures can be applied with great efficiency by using a Knapsack sprayer with Vermorel nozzle or a barrel pump, drawn upon a stone-boat between the rows.

THE FARMER'S APPLE ORCHARD.

By D. W. Beadle, Toronto, Ont.

Apple trees will grow in a great variety of soils, yet will give the best results when grown in a well drained, calcareous (lime) loam. A northern exposure is preferable to a southern one, and high ground to low land.

Trees four years old from the bud or graft bear transplanting better than those that are older; at five years after being set in the orchard they will be better trees than those that are much older when planted. They will yield better flavored and higher colored fruit when planted well apart, ordinarily forty feet each way is the proper distance. Plenty of sunlight and free circulation of air, are essential to the healthy development of the foliage, in which the processes of assimilation are carried on; in addition the conditions are not so favorable to the growth of the fungus, *fusicladium dendriticum*, which causes the well-known apple scab.

Pruning.

Every spring the orchard should be carefully examined before the weather has become warm enough to start the sap, and the trees pruned with a knife wherever needed to prevent the head from becoming too dense. If properly pruned it will rarely be necessary to use any other instrument; the cutting off of large limbs should be averted by removing them when small. When it is necessary to take off a large limb, the better plan is to cut away only a part of it each spring, thereby lessening the size of the final cut in its proportion to the size of the trunk, thus enabling the tree to heal in less time.

Varieties.

The varieties to be planted for home use will depend somewhat upon personal preferences, and much upon the conditions in which the planter is placed. It is advisable before deciding upon the kinds, to examine the bearing orchards of the vicinity, and make choice among those that do well in similar soil, exposure and temperature.

The following varieties are named about in the order of ripening: Yellow Transparent, Red Astrachan, Oldenburg, Chenango, Gravenstein, Ribston Pippin, Blenheim Pippin, Snow apple, Tompkins

King, McIntosh, Tolman Sweet, Sutton Beauty, Baldwin, Pewaukee, Northern Spy, Grimes' Golden, Golden Russet, Roxbury Russet. A selection can be made from these adapted to a very considerable part of the Province.

In planting for market, selection can be made with advantage from Oldenburg, Gravenstein, St. Lawrence, Ribston Pippin, Wealthy, Blenheim Pippin, Tompkins King, Baldwin, Northern Spy, Golden Russet, Ontario, Roxbury Russet, R. I. Greening and Westfield, Seek-no-further. When planting a commercial orchard it is important to avoid a multiplicity of varieties, and yet not to plant a very large number of any of the following in a block by themselves, for the reason that they are self-sterile; that is, the pollen does not fertilize its own blossoms: Gravenstein, Tompkins King, Northern Spy, Red Astrachan, Roxbury Russet, Tolman Sweet; these are self-sterile The Baldwin and R. I. Greening are self-fertile.

Those intending to plant an orchard for commercial purposes will do well to plant with an eye to the British market, for often that will be our best market, and fruit that will command a high price there will sell in any market. The following varieties when well grown, free from scab and all other imperfections, including worms, well graded, honestly and neatly packed, will always command a high price.

The Oldenburg, if picked before it shews any yellow and after it has put on its bluish color, ships well, if properly handled, and arrives there in prime condition. The next in season is the Gravenstein, and it commands the very highest price, next the Saint Lawrence, and close upon it the Ribston Pippin, which when prime sells there for over twenty shillings sterling per barrel. The Blenheim Pippin rivals the Ribston in price. These two varieties when prime will always sell there at high figures. Hitherto the Baldwin has been a profitable apple to send to the British market, and sells well, especially when high colored. Yet it is very questionable whether it will maintain its position, because of its lack of high quality. The Rhode Island Greening is gaining in favor there bidding fair to outstrip the Baldwin before long. Tompkin's King is much esteemed and sells at high figures. The Northern Spy when well grown is also much esteemed in its season.

Spraying.

The fungus that causes the apple-scab has become so very abundant and so widely diffused, that it is important to act energetically and persistently in the use of the most efficient means for preventing it from getting in its injurious work. Unless this is done a large share of many of our very valuable apples will often be unfit for market. The point to be aimed at in this warfare is to kill the fungus spores

before they have commenced to grow. As at present advised the most efficient means of doing this is to spray the trees in the spring, once before the buds burst and again just as they begin to unfold, and before the flowers open, with *modified eau celeste*; after the blossoms have fallen to spray them twice with *Bordeaux mixture*, to which Paris green has been added in the proportion of ¼ lb. to 50 gallons of the mixture. If the weather is dry, an interval of ten days to two weeks may intervene between the sprayings made before the blossoms appear and between those after the flowers have fallen; but if it is rainy it will be necessary to spray oftener, even to giving a spraying every week, making three with the *eau celeste*, and three with the Bordeaux mixture and Paris green.

Modified eau celeste is made by dissolving two pounds of copper sulphate (blue-stone, blue vitriol) in hot water, say two gallons. Do not use an iron or zinc vessel. A convenient way will be to put the blue stone into a water-tight barrel and pour the hot water upon it, and stir with a stick occasionally until it is all dissolved. In another vessel, no matter of what it is made, dissolve one pound and a half of carbonate of soda (common washing soda), in say a gallon of water, cold or hot as is most convenient. When both of these have become wholly dissolved, pour the soda solution into the barrel containing the solution of blue vitrol. When the chemical action which will now ensue has ceased, pour into the barrel one quart of ammonia of the strength of 26°, and stir the liquid. In a short time there will be a clear blue solution. Now add enough water to bring the whole up to thirty-two gallons. If convenient to use rain water it is preferable.

Bordeaux mixture is made by dissolving six pounds of copper sulphate in say five gallons of hot water. Take four pounds of fresh caustic lime, adding water enough to make a thin white-wash; fasten a piece of coarse sacking over the barrel containing the solution of blue-stone, and strain the thin white-wash into it. When this is done add enough water to bring the whole up to forty gallons. The cost of this will not exceed one and a half cents per gallon. It is necessary to add the lime in order to prevent the copper sulphate from injuring the foliage.

In order to kill the apple worms before they have time to eat their way into the apples it is necessary to add Paris green to poison the worms. The proportion that is advised is at the rate of one pound of Paris green to two hundred gallons of water. This would require six and two-fifths ounces of Paris green to be added to the forty gallons of Bordeaux mixture. Six ounces, however, will be found to be sufficient. By thus combining the poisonous Paris green with the copper sulphate, we are able to kill two birds with one stone; to prevent the fungus from making the apple scabby and the young worms of the codling moth from spoiling the fruit.

In order to throw the spray upon the trees it is necessary to have a force pump made for the purpose. This should have sufficient capacity to enable the operator to work without severe fatigue, for at best it is hard work. The cylinder should be not less than two and a half inches in diameter, with a stroke of five inches in length, and the handle long. It is also important that the working parts should be of brass, or at least brass lined, for the action of the chemicals soon corrodes the iron. When spraying with the Bordeaux mixture, or with Paris-green, it is very important to keep the liquid constantly stirred so that the lime and Paris-green may not settle at the bottom. One spraying pump is provided with a small pipe, through which a continuous stream is forced against the bottom of the barrel by the pressure from the air chamber, to keep the lime or Paris green, or both when used together well suspended in the water. Whether this result is attained satisfactorily, the writer is unable to say, never having used or seen one in operation.

The best nozzle is that known as the Vermorel nozzle. It is provided with a spindle which can be thrust forward by pressing the thumb upon a button to clear the vent from any obstruction, and which is drawn back by a spring the instant the thumb is removed. This nozzle produces the finest vapor spray, and does not use up half as much liquid to cover a given surface, as other nozzles. The spray can be thrown with this nozzle a distance of fifteen feet, not more; but a solid stream can be thrown a distance of forty feet, when such a stream is required, by unscrewing the Vermorel attachment.

After using the pump in spraying, always pump clear water through it and the hose and nozzle; else the lime will harden in the working parts and cause great trouble.

Some Injurious Insects.

If the apple trees are infested with leaf-eating worms, such as the canker worms, *Anisopteryx vernata* and *pometaria*; the yellow-necked caterpillar, *Datana ministia*; the red-humped caterpillar, *Œdemasia concinna*; all such can be poisoned by spraying the trees with Paris green in water in the proportion of one pound of Paris green to two hundred gallons of water. The tent caterpillars, *Clisiocampæ Americana*, are more easily destroyed by capturing them when they are in their tent, where they are sure to be in the early morning, at mid-day if the sun shines bright, and at evening. The fall web-worm, *Hyphantria textor*, keeps within its web until it has nearly attained its full growth and therefore can be easily captured at any time of day. Sometimes the forest tent caterpillar, *Clisiocampa sylvatica*, invades our orchards; when it does it usually comes in countless numbers, and can be best destroyed by spraying with Paris green.

Benefits of Spraying.

The efficacy of the means herein mentioned for preventing injury to our apple trees and apples from the apple scab, the codling moth worm, and leaf-eating caterpillars is no longer open to question. They have been most thoroughly and frequently tested, not by one person only, or in but one locality, but by very many persons, in very many places and under a great variety of circumstances; all testifying to decidedly beneficial results which abundantly compensate for all cost of labor and material. The results obtained by spraying an orchard of Tompkins King last season, 1893, as stated by Mr. E. G. Lodeman, are here given as one of many instances that might be mentioned. The material used was the Bordeaux mixture. Some of the trees were sprayed only twice, namely May 19th and June 8th; others four times, April 26th, May 19th, June 8th, and June 22nd; and yet others six times, April 26th, May 19th, June 8th and 22nd, July 13th and August 1st. On April 26th the buds were swollen almost ready to burst, on May 19th a few blossoms still remained on the trees, on June 22nd the young apples were set. At this date Paris green was added to the Bordeaux mixture, and used in this and all subsequent sprayings. The proportion of Paris green was equivalent to one pound in two hundred and fifty-six gallons of water, or two and a half ounces to the fourty gallons of Bordeaux mixture. The apples were gathered about the middle of September, the fruit from each tree piled by itself, and divided into three grades; the first of entirely fancy fruit, only strictly first class apples put into it; the second of symmetrical and even large apples of good color, if several, even small, spots could be found on their surfaces; the third averaged as good as the ordinary barrelling apples of the country. From the trees sprayed only twice, 55 per cent. were first grade, 43 per cent. second, and 2 per cent. third; with 11 per cent. wormy. It will be remembered that the trees sprayed only twice received their sprayings before the codling moth would have laid many, if any, eggs. The trees sprayed four times gave 53 per cent. first grade, 46 per cent. second, 1 per cent. third, with 6 per cent. wormy. Those sprayed six times yielded 76 per cent. first grade, 19 per cent. second and 5 per cent third, with 4 per cent. wormy. The trees left without spraying, for the sake of comparison, gave 25 per cent. first grade, 56 per cent. second, 19 per cent. third, with 9 per cent. wormy. The gain from two sprayings was 120 per cent, from four was 112 per cent., from six 2[illegible] per cent. of strictly first-class fancy fruit. The apples were subsequently sold, consisting of 65 barrels, the buyer graded them thus: 59 barrels firsts, 4½ seconds, and 1½ thirds; that is, he made 91 per cent. firsts, 7 per cent. seconds, and 2 per cent. thirds; whereas Mr. Lodeman makes his highest percentage

of firsts only 76 per cent., which was from the six sprayings; while the average of the whole, the two, the four and the six sprayings, is 61.3 per cent. The difference between this and 91 per cent., as graded by the buyer, indicates the high standard of Mr. Lodeman's grading.

The small size of many of the farm orchards and the multiplicity of varieties of which most of these is composed, together with the pressure of other farm work in spring, may make the spraying of orchards seem an added burden too great to be taken up for the amount of gain. This, however, might be overcome by a number of farmers that live contiguous to each other combining for this purpose, uniting in the purchase of the requisite outfit, and engaging a competent person to prepare the material, do the spraying, and care for the machinery. The amount of liquid required to efficiently spray an orchard of large apple trees will average about four gallons per tree; less will not be sufficient to cover all parts of the tree properly, if more is used the excess will fall to the ground. Two men, one to drive and do the spraying, the other to work the pump, can thoroughly spray at least one hundred such trees in a day.

Again, most farmers wait for a buyer to come and take the fruit at such price as he may think best to offer. This man expects to make a profit sufficient to pay for his time and expenses; the wholesale dealer to whom he ships must have his commission, and if sent to Great Britain the consignee there has his commission. Why not unite also in shipping the fruit direct to the market and thereby save to the producer the profits of at least the travelling buyer?

In closing this paper the writer desires to impress upon the farmers the importance, nay, the absolute necessity of spraying their apple orchards every spring. The apple-scab and the codling worm have been allowed to go unchecked so long that there is not an orchard in the country that is not suffering from the injuries inflicted by these pests. While we were ignorant of the means of preventing these injuries there was no help for it, but now there is no excuse for us if we allow these to continue. It is not only that the apple-scab fungus spoils the apples, but by its great injury to the leaves weakens the trees, so that the fruit which escapes being scabby, does not attain its full size. Nor is the codling worm the only insect injurious to the orchard that the spraying kills. The tussock moth, the yellow-necked and red-humped caterpillars, the canker-worms, the leaf-roller, the leaf-folder, the leaf-crumpler, the very small but very injurious eye-spotted bud-moth, the Palmer-worm, and others that might be named, are usually on hand to add their quota of harm. If we are to secure first-class prices for our apples, we must grow first-class fruit, and there is nothing more certain than the fact that we cannot gather first-class fruit if we do not spray our apple orchards every season.

STRAWBERRY CULTURE

By W. W. Hilborn, Leamington, Ont.

It is doubtful whether there is a farm in Ontario on which strawberries cannot be grown profitably for family use, and still there are thousands of farmers that do not grow them. This should not be the case, as they can be grown with so little trouble and expense. Strawberries ripen during the heat of early summer, when such an addition to the diet is most healthful and necessary.

Many have been deterred from planting the strawberry from the fact that their culture is not understood. It is a common opinion that a great deal of work is required to make them succeed. When grown in the old fashioned way of planting in beds in a garden or enclosure this is true. All the work has to be done by hand, mostly at a time when the farmer is so busy with the spring work on the farm he cannot attend to the strawberry patch. The location of a suitable place for the strawberry plantation often has much to do with the success or failure of it. Especially is this true with the farmer that has but little help, and can ill afford the time to give them proper care. This class of farmers are very numerous and it is the purport of this paper to make the method of culture so easy and simple that many who do not now grow the strawberry will be induced to grow at least enough for family use.

Soil.

Any soil that will produce a crop of corn or potatoes will answer for strawberries. A rich clay loam is to be preferred, next, a sandy loam. Avoid if possible a stiff heavy clay as much more difficulty will be experienced in making a heavy tenacious soil. Also avoid any land that has been in sod or pasture a number of years. The *white grub* is the most destructive insect enemy we have to fight in growing the strawberry. It is usually found in the greatest numbers in the soil that has recently been two or more years in sod. A clover sod that has had but one crop taken off will answer. If the soil is not naturally rich it will pay to make it so with either barnyard manure or commercial fertilizers. It should be well drained either naturally or by tile draining.

Location.

Select some convenient place where you will have to go out of the way to cultivate. You can then go through them with horse

and cultivator in a few minutes when you have been cultivating corn, potatoes or other vegetables and never miss the time; while if they were planted in some out of the way place they would often go without cultivation until the weeds got such a start that they could afterwards be cleaned out and cared for only with great difficulty. This is often the cause of failure. It is preferable to select a piece of land sufficiently large to admit of future plantings along one side.

Preparation of the Soil.

If a clay or sandy loam or a one year old clover sod, it should be well ploughed in the autumn. If a light sandy loam, plough in early spring. After ploughing, top work the soil thoroughly in the spring as soon as the weather and the condition of the soil will permit. Cultivate deep with a two-horse cultivator and harrow down smooth. If the soil requires manure, apply well rotted barn-yard manure just before cultivating and harrowing. The manure should be well mixed with the top soil but not plowed under. A stiff, heavy loam may have an application of coarse barn-yard manure in the fall before plowing. If the soil is stiff or heavy, it should be trenched up in the autumn by turning two furrows together, forming a sharp ridge as when prepared for carrots or other roots. When thus exposed to the action of the frost a comparatively heavy soil will work down fine and mellow in the spring and give good results. Care must be taken, however, never to stir such soil when wet, either with plow, hoe or cultivator. Surface drains should be made to take off surplus water quickly.

Planting.

This should be done as early in the spring as the soil can be prepared as directed above. Mark off the rows with a corn marker about four feet apart. If a marker is not at hand stretch a cord to plant by. Take pains to have the rows straight and of equal distance apart. It adds to the appearance of the plot, and time is saved in the cultivation. Procure plants of the previous year's growth, trim off all old runners and dead leaves and shorten the roots to about four inches. Keep the plants moist and where the wind cannot reach them while out of the ground. This can easily be done by placing them in a pail or box and covering slightly with soil and taking them out only as fast as required for planting. When planting make a hole with a spade crosswise of the mark and deep enough to admit the roots without doubling them up. This is quickly done by shoving the spade straight down and pushing it backward two or three inches. Take the plant in the left hand, spread out the roots fan-shaped, place the crown on a level with the surrounding soil, fill in and work the soil well in among the roots and press so firmly that by giving a quick jerk on a leaf it will break off without moving the plant.

Cultivation.

As soon as the weed seeds start to grow and appear above ground, cultivation should begin. A fine-toothed cultivator is the best. Stir the soil frequently to a depth of about two inches, especially during the early part of the season. Care must be taken not to stir the soil immediately around the plant or injury will result. Cut off all the blossoms and first runners until the plants have sufficient strength to send out several strong runners at once, (which is usually in July) when these may be allowed to take root. The soil between the plants in the row that cannot be worked with the cultivator should be hoed out as soon as the weed seeds start to grow. At this time a steel garden rake will often do the work better and more quickly than a hoe. If the weeds are allowed to grow until they are two or three inches high before hoeing more than double the labor will be required, and the results will not be so good.

Mulching.

As soon as the ground freezes in the autumn sufficiently hard to prevent horses and waggon from breaking through the crust, a mulch should be applied. This may consist of coarse manure, wheat or rye straw or marsh hay. Most of the material should be placed between the rows with just enough immediately over the plants to nearly cover them from sight. In early spring, as soon as growth begins, rake the mulch from off the plants and leave it between the rows. If the mulch is left on the plants for a time after they begin to grow, it causes a soft weakly growth of plant that will not produce fruit.

Keeping up the Plantation.

This is often the most difficult problem to solve in strawberry culture on the farm. The usual practice has been to plant out a plot and give good care the first season; result, a fine crop of fruit, with a promise that the strawberry patch shall be cleaned out and cultivated as soon as the fruit is off. This, however is rarely done; after the fruit has been gathered we do not expect any more until next season. The ground gets too dry to cultivate and the haying and harvesting has to be attended to. The strawberry patch then gets a promise that it shall be cleaned out early the following spring. When spring comes the grass and weeds have such a strong hold among the plants that it is usually decided to let them go without any attention. With this treatment, at the end of the third season the plants will generally be so exhausted that but little fruit is produced and the young plants seldom possess that vigor required for starting another plantation successfully.

By adopting the following plan no difficulty will be experienced and a crop of strawberries can be grown as easily as a crop of potatoes, and with as little risk of failure.

Plant four or more rows one hundred feet or more long, *every spring* and grow as directed above. This will yield a sufficient supply for an average family, and if a selection is made of early and late varieties the season of ripening may be extended to four or five weeks. A new plantation can be put out every spring and cared for with much less time than would be required to clean out the old one. With this method a supply of strong healthy plants can always be had for replanting—a most important point in successful strawberry culture.

A plantation can be left to fruit the second season without any cultivation, you will obtain the earliest fruit from this old plot, and in a favorable season quite a large quantity of it. The greatest objection to allowing the plantation to remain for a second crop is, that it so often happens that a new plantation is not set out, if the old one is left for a second crop. The chances are therefore lessened for a future supply of both fruit and plants.

Selection of Varieties.

Every season some new sorts are introduced that, could we believe the disseminator's description, would excel all other kinds. But how seldom do we find one of these new highly lauded varieties that proves as valuable as some of the old, well tested kinds. Many of them have a local reputation and prove valuable with special care in localities suited to their wants. It is not possible to give a list of varieties that will do equally well in all localities. If you have a neighbor that succeeds with certain kinds on similar soil to your own, it is usually safer to plant the same sorts. This will generally give better results than to trust new varieties, no matter how much they have been lauded by the disseminator. Occasionally it is well to test new sorts in a small way, but this can mostly be left to those who can afford to experiment.

The following varieties have given satisfaction over a large area. For early, Beder Wood (B.) and Crescent Seedling (P.). For medium and late, Bubach (P.), Wilson (B.), Woolverton (B.), Saunders (B.), Lovett (B.), Williams (B.). Those marked (B.) are bi-sexual or perfect flowering varieties. Those with pistillate or imperfect blossoms are marked thus (P.) and require one row of the former with every three or four rows of the latter to fertilize them properly. The attention of farmers and amateur fruit growers is specially directed to this fact. Many of our most heavily producing strawberries (those marked P.) have only imperfect blossoms, and in order to produce fruit they must have planted along with them, or near by, other

varieties (those marked B.), that have perfect blossoms, from which the wind and insects will then carry the pollen to the imperfect blossoms of the other plants.

Those named are vigorous growing varieties and should be planted about one and a half feet apart in the row, and rows four feet apart. They can be relied upon for either home use or market.

Bubach has given the largest yields on light or sandy soils, and the fruit is of the largest size. Beder Wood is perhaps the best, first early on light soil, and Crescent on stronger loam. Woolverton and Saunders succeed best on strong rich soil, and with good cultivation will give a crop of fruit that is difficult to equal either in size of fruit or quantity. The fruit is of a dark bright crimson color, of good quality and quite firm for so large a fruit.

Procuring Plants.

Procure plants from your own vicinity if you can get suitable varieties. If not, send to some reliable firm that charges enough for their plants to pay for good and careful packing. Poor plants are dear at any price and usually result in failure.

Growing for Local Market.

Many towns and villages throughout Ontario have to procure their supply of strawberries from a distance. Where such is the case it would pay some farmer in the vicinity to grow them for the local market. Begin in a small way and learn the methods best adapted to the conditions and wants of the locality. Strawberries fresh from the field will always bring a higher price than those which have been shipped in by train. There are few localities where strawberries cannot be grown in sufficient quantities to supply the demand, if proper methods of cultivation are followed.

PLUM CULTURE.

By G. W. Cline, Winona, Ont.

Plum growing is a source of profit too often neglected by the farmers of this Province. With the exception of perhaps the apple, the plum can be grown more easily and cheaply than any other fruit. The advantages to the farmer in raising plums are two-fold: In the first place, his family can derive both pleasure and benefit from the use of the fruit while ripe and fresh in summer and fall, and also when canned or preserved it can be used in winter and spring. In any of these forms few fruits are more pleasant, palatable and wholesome than the plum. In the second place, the plum is one of the most profitable fruits for market, and this is no small consideration. For these reasons every farmer should have a plum orchard, small or large, as his experience may suggest.

Soil, Preparation and Planting.

Any good, dry soil will grow plums. If not dry, drain the land with tile or stone at least 2½ or 3 feet deep, or pine poles with a slab will do in case the other materials are not available. Plums will do well on all soils, from the lightest sands to the heaviest clays, by planting the proper varieties. A rather elevated situation is better than low land, as the trees in such a location are not so likely to be affected by late spring frosts. In preparing for planting, if the soil is a heavy clay sod, it is best to plow in narrow ridges in August and to harrow well in the spring. Then open out the ridge with the plow deep enough for setting out, plant in the bottom of the furrow and plow the soil back to the trees again; the rotting sod will help to keep the soil moist. For sandy or loamy soil, where the land will not bake by spring plowing, the best way is to plow and leave the furrow just where you want your row of trees, and plant as above. By this means you can plant a large number of trees in a day, and if the soil is properly pulverized and cultivated there should be no loss. If the season is inclined to drouth, mulch with coarse, strawy manure, but do not pour water down by the roots, as that washes the soil from the roots and causes

more harm than good. Before planting the young trees it is well to make a thin mortar of fine earth and water and dip the roots into it, in order to keep them moist; do not keep the fibrous roots exposed to the sun or wind. In planting, lean all trees towards the prevailing winds, so that in growing they may stand up straight, and if they should be inclined to lean the wrong way bank up with earth and press them over. When loaded with fruit they are very hard to keep in upright shape, and if once allowed to be bent over with the yield they cannot be brought back to stay in an upright position.

As to the distance apart in planting, 12x16 is sufficient for most varieties, but for some of the larger and more spreading growers 14x16 is better. Among these latter varieties are Glass's Seedling, Quackenbos, Gen. Hand, German Prune, Yellow Egg and Victoria, and where you have land to spare, and it is rather rich, give them plenty of room, and you will not be sorry.

Cultivation of the Orchard.

Having set out your orchard, plant corn, roots or potatoes, and give plenty of cultivation, and if your trees were in good order when planted you will have success. Do not sow grain or turn to grass until the trees are at least three or four years old, when, if they are growing too large and are not blossoming, one season of grain or grass will cause the fruit buds to form; then turn to cultivation again, and you will not be likely to have any further trouble on account of the trees not fruiting.

Varieties.

Look about your own neighborhood and see what varieties are doing well, and in what kind of soil. Plant the best and most successful of these suitable to your own soil and conditions, and you will not be disappointed. Add a few other varieties for testing, but be careful in buying, remembering that the climate and soil vary so much in Ontario that no list of varieties would stand everywhere in the Province. If growing for profit, I would advise the planting of only a few varieties of tried reputation. Do not take the advice of any agent who comes along as to what sorts to set out, as such individuals are generally most anxious to sell what has been sent out with much puffing, one-quarter of which may not be true. Buying after this fashion is filling the Province with worthless varieties of fruit. Do not buy more than a tree or two of any new variety.

My list of plums for my own locality, as well as for all the southern part of the Province and some of the northern portion,

in order of ripening, is as follows: Bradshaw or Niagara, Duanne's Purple, Imperial Gage, Washington, Smith's Orleans, Huling's Superb, McLaughlin, Lombard, Pond's Seedling, Glass's Seedling, Quackenbos, Yellow Egg, German Prune and Reine Claude de Bavery. The above are for clay or clay loam, and all are good growers and good bearers. For a sandy soil, which is not recommended as the best for plums, I would suggest: Duanne's Purple, Imperial Gage, Washington, Huling's Superb, McLaughlin, Lombard, Glass's Seedling, Reine Claude de Bavery and Coe's Golden Drop. In addition to the above are many more worth trying for those who care to experiment with varieties, such as Canada Blue, Peter's Yellow Gage, Genii, Jefferson, Fellemburg, Shipper's Pride, Shropshire Damson, Grand Duke, Saratoga, Field, Victoria, Gen. Hand, Prince of Wales, Red Egg, Lawson's Golden Gage, Prince's Yellow Gage, Bingham, St. Lawrence, Munroe Egg, Canada, Orleans, Prune de Agen and Abundance.

The Use of Fertilizers.

If the soil is not naturally rich it is of the greatest importance that some fertilizer should be applied. Barnyard manure, on account of the nitrogen it contains, is probably the best, but ashes and bone meal are generally required when the orchard is in full bearing condition, and these may each be applied at the rate of about 200 pounds an acre. Some soils, such as clays of a greasy nature, are full of potash, and consequently require only nitrogen and phosphate (or bone), and to use ashes on such land would be simply throwing them away. But in the case of sandy or loamy soils, where there is plenty of sorrel growing, the opposite is the case, and the ashes should be applied to sweeten it. Plum trees have been known to bear well under neglect, but that was where the new soil was rich and there was no black-knot or curculio to attack them. Now all this is changed, and if you want a long lived, profitable orchard, do not neglect to give the best of care in cultivation and fertilizing, or otherwise black-knot, bark sun-scald and death will finish them.

Black-knot.

I had so much black-knot a few years ago that I thought I was going to lose my orchard. However, I commenced cutting off the knot and burning it. Three times a year—in July, September and February or March—we went through the orchard, and also fertilized it well with nitrogen, phosphoric acid and potash. Trees revived where nearly dead, and at the present time I have but few cases of black-knot, and they are hard to find.

The Rot.

The rot is a very serious disease, and it has been increasing for some years. I am now fighting it with Bordeaux mixture and sulphur, and I also pick off all rotten fruit, scalding them or burying them deep in the ground. I believe this is the best remedy, but I would like to have still another season's trial before finally deciding. My plan of operation has been as follows : Apply ammoniacal solution before the buds come out in leaf, then, after blossom, Bordeaux mixture two or three times, and throwing sulphur in the trees about the time of ripening. There are some who think plum rot is caused by a worm. To a certain extent this is true, as the plum is first stung by the curculio ; the spores of the fungus being at hand, the root attacks the spot, and by the time the rot has fully developed the worm has worked its way into the plum, and is taken as the cause of the rot. I would advise growers of plums to closely look after all rot, and pick every affected plum as fast as they can be found rotting, and in this way save the crop not only for that season, but make it better for the orchard in the succeeding year.

Insect Enemies.

Of the insect enemies of the plum the curculio is the worst, and it appears to be always with us. My remedy is Paris green, 3 ounces to 40 gallons of water, sprayed on the trees just after the blossoms are all gone. Do not spray before that time, as it will then be of no use whatever. After the first application spray again at intervals of a week or ten days if no considerable amount of rain has fallen, but if heavy rain occurs spray oftener. I have sprayed as often as six times during the season with no harm resulting to the trees or foliage. When coming to the bottom of the barrel we have sometimes found that the solution was rather strong, and that some of the leaves have been scorched, but never sufficiently so as to damage the tree for future bearing. Be careful and weigh your Paris green. *Do not guess*, as some men, more especially employees, are inclined to do. Few men have an accurate idea of size or weight. In battling with the curculio Paris green has proved most effective with me, and far ahead of the old plan of jarring the tree. I have tried both methods, but for twelve years have not jarred, but used the arsenite. The canker-worm is another pest which is also killed by Paris green when spraying for the curculio, and many other injurious worms are also destroyed in the same way. The green aphis, however, is becoming very bad, as it is hard to get at, since its habit is to work on the under side of the leaf, which curls over and largely protects it. For this pest I use coal-oil emulsion, and

whenever it touches them they are killed. I used only the horse-power sprayer on them last season, but will try the knapsack or a barrel on the stone-boat this summer so as to get close under the trees and thus get all of them covered.

Marketing.

The marketing of plums demands considerable attention. I have always followed the rule to pick only the plums that are ripe; that is, all that are finely colored but not soft. Pack into 12-quart baskets (some prefer 8-quart baskets) and ship to orders, which should be arranged ahead as much as possible. We pick off the same trees for from three to six days, and never send any but the best to market. Many growers pick their plums a week ahead of ripening, and pick all at once, putting on the market what is nothing but a miserable apology for a plum, the fruit being really not fit to eat. It is a shame, and certainly a great mistake from a business point of view, to put plums on the market in so green a condition as to be unfit to be used. You cannot sell your plums well if you pick them too green. If you have secured no regular customers to take your plums, send the fruit on to a reliable commission man (and there are many of them), who can be depended upon to do the very best for an equally reliable customer.

FRUIT STATISTICS

The following table contains the numbers of apple, pear, peach, plum and cherry trees, and of grape vines in the townships of Ontario as computed for 1892 and 1893, from returns sent in by farmers and fruit-growers to the Department of Agriculture (Bureau of Industries.)

Districts.	1893.		1892.	
	Bearing Age.	Young Trees.	Bearing.	Non-Bearing.
APPLE TREES.	No.	No.	No.	No.
Lake Erie	1,296,335	409,771	1,264,495	459,296
Lake Huron	800,837	249,856	751,637	254,074
Georgian Bay	500,747	242,374	450,135	223,953
West Midland	1,164,110	292,200	1,097,843	308,063
Lake Ontario	1,993,891	447,905	1,961,607	460,617
St. Lawrence and Ottawa	786,100	316,937	750,621	309,334
East Midland	373,917	153,799	346,407	152,896
Northern Districts	17,426	31,839	15,235	32,711
The Province	6,933,363	2,144,681	6,637,980	2,200,944
PEAR TREES.				
Lake Erie	134,047	84,617	121,224	92,918
Lake Huron	46,975	27,246	45,216	28,137
Georgian Bay	22,486	33,253	17,474	32,556
West Midland	72,803	48,625	61,929	46,045
Lake Ontario	211,702	294,560	205,976	273,788
St. Lawrence and Ottawa	20,830	15,877	19,199	14,383
East Midland	12,071	9,834	14,045	10,992
Northern Districts	838	1,153	213	693
The Province	521,752	515,165	485,276	499,512
PLUM TREES.				
Lake Erie	56,230	82,400	48,533	79,291
Lake Huron	56,617	37,766	59,129	40,306
Georgian Bay	85,502	80,002	93,962	85,120
West Midland	68,337	75,957	62,943	74,317
Lake Ontario	247,960	333,427	225,181	332,743
St. Lawrence and Ottawa	127,226	40,589	130,732	38,970
East Midland	31,212	22,414	30,041	24,854
Northern Districts	9,477	7,539	8,933	7,814
The Province	682,561	680,094	659,454	683,415

FRUIT STATISTICS.—*Continued.*

Districts.	1893.		1892.	
	Bearing Age.	Young Trees.	Bearing.	Non-Bearing.
Peach Trees.	No.	No.	No.	No.
Lake Erie	173,392	153,080	141,502	182,536
Lake Huron	10,516	7,055	9,118	8,275
Georgian Bay	1,688	3,013	1,859	1,322
West Midland	17,124	9,660	12,658	11,824
Lake Ontario	319,054	212,804	277,765	229,720
St. Lawrence and Ottawa	.....	204	.....	253
East Midland	99	498	198	617
Northern Districts	....	16	.....	7
The Province	521,873	386,330	443,100	434,554
Cherry Trees.				
Lake Erie	166,145	52,853	163,610	58,369
Lake Huron	82,713	27,535	81,138	29,420
Georgian Bay	53,293	28,769	54,796	23,314
West Midland	77,017	30,862	76,368	30,017
Lake Ontario	94,338	63,182	93,713	55,776
St. Lawrence and Ottawa	28,945	14,962	29,731	10,629
East Midland	13,954	10,046	12,348	10,684
Northern Districts	1,659	1,449	1,471	1,837
The Province	518,064	229,658	513,175	220,046
Grape Vines.				
Lake Erie	922,042	195,408	962,265	250,708
Lake Huron	37,506	34,335	35,715	24,762
Georgian Bay	23,194	8,774	28,455	8,052
West Midland	55,870	24,879	48,259	29,028
Lake Ontario	1,117,502	473,981	1,029,479	571,626
St. Lawrence and Ottawa	40,037	18,048	37,135	44,704
East Midland	26,013	26,864	31,911	20,605
Northern Districts	1,118	1,141	914	1,174
The Province	2,223,282	783,430	2,174,133	950,659